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Apple Varieties AND IMPORTANT PRODUCING SECTIONS OF THE UNITED STATES

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THE APPLE, introduced into North America by the early white settlers, was carried to all parts of the United States as rapidly as the country was settled. Originally a part of almost every farm enterprise, apple production in recent decades has become largely a specialized business, located in those sections where climatic and soil factors are favorable. This change has resulted largely from the increase in insect and disease problems and the necessity for repeated spraying in practically all sections if sound, attractive fruit is to be produced.

The varieties of apples grown are also changing. Recently planted orchards are mainly of varieties high in dessert quality. Many low-quality varieties, formerly popular because of long keeping in farm storages or because they would produce well under partial neglect, are being replaced by better quality kinds.

In this bulletin, the important climatic and topographic features of the main apple sections of the United States are briefly indicated, the insect and disease conditions discussed, and the characteristics of leading varieties are described.

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APPLE VARIETIES AND IMPORTANT PRODUCING SECTIONS OF THE UNITED STATES

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DEVELOPMENT OF THE APPLE INDUSTRY

THE APPLE, cultivated for more than 2,000 years in Europe, was brought to North America by the earliest settlers. Before the colonization of North America many varieties had been selected in Europe, and seed of these European varieties, and in some cases grafted trees, were transported to America. Within a few years after the first settlements were made in the temperate parts of North America, bearing apple trees were reported.

From these early plantings apple trees were rapidly disseminated. Seed was carried by the Indians, traders, and missionaries into the wilderness far beyond the white settlements. In many cases apple orchards were found adjacent to Indian villages. All of these so-called Indian orchards consisted of seedling trees. Thus the apple was carried westward simultaneously with or even in advance of the earliest white settlements.

In 1847 Henderson Lewelling took a load of nursery stock by ox team and wagon from Iowa to western Oregon. From this stock the early plantings of the Pacific coast were established. Thus by the middle of the nineteenth century apples were established from coast to coast throughout the temperate part of the United States.

Practically all of the earliest orchards were of seedling trees, and in many sections of the country the apple became partially naturalized, with seedling trees scattered along fence rows, in pasture lands, and other places. From these millions of seedling trees, those that appeared superior were propagated and tested under orchard conditions. Most of the varieties now grown commercially have been propagated from these seedlings. A few varieties were imported directly from Europe, and in recent years a few developed by systematic breeding are attaining commercial prominence. It is probable that most of the new varieties of the future will come from such breeding work.

Orcharding during the nineteenth century was largely a farm operation with no intensive care being given to the trees. A few trees to a few acres of orchard were established on most of the farms. Spraying of these orchards was unknown, and fertilization, beyond the occasional application of barnyard manure, was not practiced. Many of the insect pests and diseases that are now widespread throughout the country were unknown or of little importance. Although there was a natural tendency to plant varieties that were relatively resistant to the diseases known at the time, much of the fruit that found its way to market was more or less affected by fungus diseases and insects.

Although certain areas during the latter part of the nineteenth century came to be known as important apple sections, orchard planting was general throughout most of the United States. The census for 1900 reported 201,795,000 bearing apple trees, or almost two and one-half times the number in 1935, which was 82,535,000. Most of these trees, however, were in small orchards receiving limited care and producing much less fruit per tree than is produced in the more intensive orchards of recent times.

The development of intensive orchard areas in the irrigated districts of the West started in the late years of the nineteenth century. The Hood River Valley became famous as a producer of fine fruit from 1900 to 1910. Extensive plantings were started in the Wenatchee and Yakima Valleys a little later.

It was not until after the beginning of the twentieth century that spraying of apple orchards became general. The invasion of the San Jose scale and the development of the lime-sulfur solution to combat it led to the rather wide application of dormant sprays in orchards maintained for commercial production. Early spraying for codling-moth control, using paris green as the spray material, resulted in so much damage to trees and fruit that the practice did not become general until after the development of lead arsenate, which became available commercially about 1903. The fungicidal value of lime-sulfur solution was not discovered until 1908. With the use of the more dilute liquid lime-sulfur for summer spraying to control fungus diseases and with lead arsenate for control of the codling moth and other chewing insects, summer spraying of apples became a general practice in commercial orchards.

The development of spraying led to many changes in the industry. The apple grower had to choose between being an intensive orchardist, prepared to spray and produce clean, attractive fruit, or going out of the orchard business. The greater proportion of the so-called farm orchards have disappeared during the last 30 years or are no longer producing fruit that finds its way into trade channels. Most of the commercial apples are now produced on specialized fruit farms where

apples and possibly other fruits comprise the principal sources of revenue.

As a result of the heavy expenditures for spraying, fertilizing, fruit thinning, and the related practices necessary to obtain adequate production of good-quality fruit, not only have the orchard units become larger, but more extensive studies have been made of the most satisfactory locations and sites for orchards. Where 1 to 5 acres of apples were grown as a part of a large farming enterprise, it was relatively unimportant whether that small unit produced satisfactorily and was so located that maximum regular crops could be expected. In a larger specialized orchard enterprise, however, much greater care must be exercised to insure the most favorable production conditions, if the farm is to prove successful.

Because of the concentration of apple growing on intensive fruit farms and in areas well adapted to the crop, the number of trees

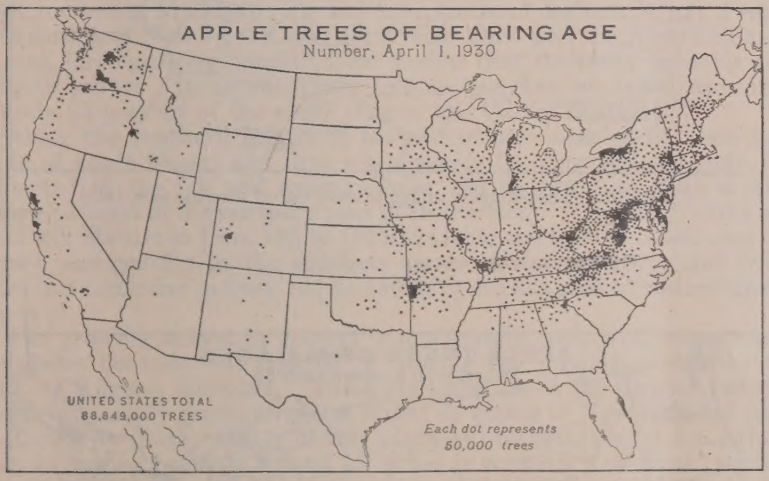

FIGURE 1.—Distribution of apple trees of bearing age, 1930.

necessary to produce a similar tonnage of fruit has decreased greatly since 1910. Also, the total apple consumption in the United States has apparently decreased during the past 30 years, with the greatly increased supplies of other fruits. Consequently, the total number of apple trees has decreased in recent years. The following tabulation indicates the extent of this decrease:

Year	*Apple trees of all ages (number)*
1920	151, 504, 000
1930	116, 304, 000
1935	100, 054, 000

Figure 1 shows graphically the distribution of apple trees of bearing age in 1930. Figure 2 shows the distribution of apple trees not of bearing age in the same year. It will be noted that most of the trees not of bearing age in 1930 were in the eastern half of the United States. Figure 3 shows graphically the distribution of the decrease in number of apple trees between 1930 and 1935. In all the important

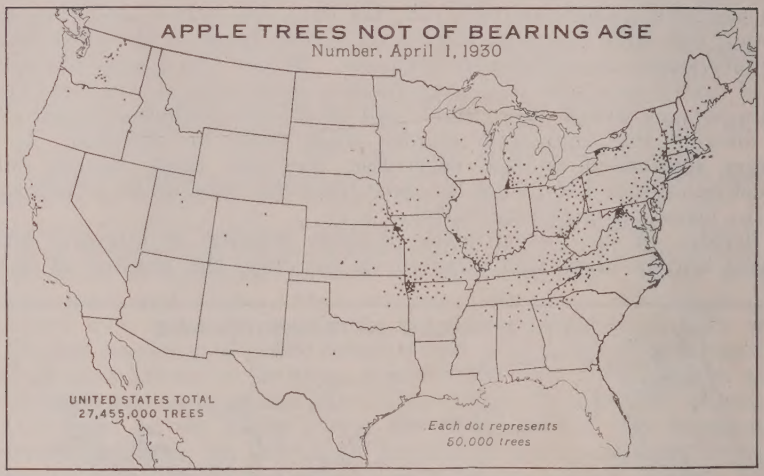

FIGURE 2.—Distribution of apple trees not of bearing age, 1930.

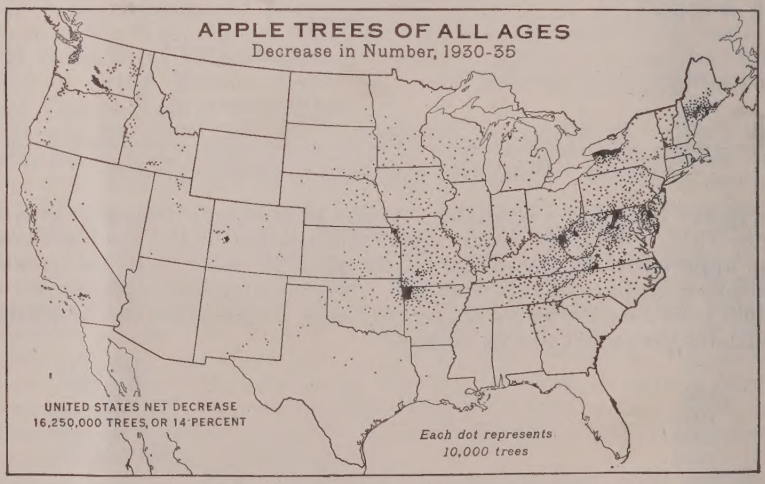

FIGURE 3.—Decrease in apple trees of all ages, 1930–35.

apple sections there was a decrease in total number of trees during this period.

Although apples are grown to a greater or less extent in every State in the Union, certain sections having the most favorable growing conditions have tended to become the main centers of apple production in the United States. The principal characteristics of these sections in different parts of the United States, the varieties that are grown, and the insect and disease conditions are discussed in the following pages.

NORTHEASTERN SECTION

LOCATION AND CLIMATE

The northeastern section is roughly bounded on the south by a line extending westward from New York City across central Pennsylvania, northern Ohio, and Indiana to Illinois. The districts north of this line, including Michigan, the northern parts of Indiana, Ohio, Pennsylvania, and New Jersey, and all of New York and the New England States, have growing conditions so similar that the same varieties are largely grown. In recent years this section has produced approximately 25 percent of the apple crop of the United States.

Along the southern border of the section the interval between the time of apple bloom and that when severe freezing weather may be expected in the fall will average from 160 to 165 days, with a still shorter season in the northern part of the section. Thus only varieties that will mature in from 155 to 160 days from the time of bloom can be grown successfully in the southern parts of the territory, and only varieties maturing in from 140 to 150 days are adapted to the northern parts.

The growing season in general is moderately cool, with mean temperatures between 65° and 70° F. during the 3 summer months of June to August, inclusive. Total precipitation in the districts where fruits are mainly grown averages about 45 inches in New England and eastern New York. West of this territory precipitation is somewhat less, averaging between 30 and 35 inches in western New York, northern Ohio, and most of Michigan. About half of the total precipitation comes during the growing season of April to September, inclusive.

Throughout most of this section precipitation is unusually dependable. The proportion of years in which the annual precipitation is less than 85 percent of the average is less than in any other major section of the United States.

With the general dependability of rainfall conditions and with a relatively cool growing season, serious moisture shortage occurs but rarely in orchards on moderately deep and well-drained soil. In soils poorly drained a high water table during the spring months may lessen growth and yield by limiting the root development of the tree.

TOPOGRAPHIC FEATURES

The White Mountains, in north-central New Hampshire and western Maine, the Green Mountains, extending in a general north and south direction in central Vermont, and the Adirondack and Catskill Mountains, in eastern New York, are apparently important factors in determining the location of the most desirable fruit sites in the New England

States and in eastern New York. Apple plantings in Maine are located mainly in the southern and eastern parts of the State, which are partially protected from severe cold from the north and west by mountains. In southern New Hampshire similar protection is afforded by the White and the Green Mountains. The Green Mountains, and farther west the Catskill Mountains, afford considerable protection to much of Massachusetts, Connecticut, and Rhode Island, and apple orchards are rather widely distributed throughout these States. The central Hudson Valley district of southeastern New York is intensively planted to apples. The Catskill Mountains, to the north and west, afford much protection to this area.

The other intensively developed fruit districts have been located largely as a result of the protection afforded by the Great Lakes. A major fruit belt occurs in western New York in the counties immediately south of Lake Ontario. A low ridge resulting from the old lake-shore line parallels the present shore from 8 to 15 miles inland. This ridge and the land between it and the lake are intensively planted to fruit. The district south of the ridge and farther from the lake is more subject to frost and freezing injury because it receives less protection from the lake.

Commercial apple orchards also occur in northwestern Pennsylvania and in northern Ohio adjacent to Lake Erie. In Michigan the most intensive development of orchards is in a tier of counties immediately adjacent to Lake Michigan, in the southwestern part of the State. The Great Lakes have such a marked tempering influence on winter temperatures that a minimum sufficiently low to injure apple trees occurs very rarely in the districts on their east and south sides. Only when the duration of cold is so long that the lakes are largely frozen over does this protection disappear. In the winter of 1933–34 along Lake Ontario in western New York many apple orchards were severely injured following such a period.

Not only do these lakes afford protection against low winter temperature, but the large masses of cold water tend to reduce temperatures in the spring and retard blossoming until the danger of severe spring frosts has largely passed. Thus protected by large bodies of water or by mountain ranges, these districts are relatively free of destructive spring freezes. Portions of this northern section that are not protected by either water or mountains are less satisfactory for fruit production, because of the susceptibility to tree injury resulting from low winter temperatures and because of increased susceptibility to spring frosts.

DISEASE AND INSECT CONDITIONS

Apple scab is by far the most serious fungus disease affecting apples throughout this section. With a relatively cool, moist spring and early summer, the weather is likely to be very favorable for scab infection. Because the growing season is moderately cool, sulfur fungicides are used mainly in the control of scab. Where an adequate program for scab control is followed in this section other fungus diseases are of relatively little importance.

Throughout the territory as a whole, control of the codling moth is less difficult than in most other apple-growing sections of the United States. The codling moth thrives best where the growing season is long, warm, and moderately dry. In the intensively planted fruit

areas in the section, codling moth control presents a serious problem, but it is relatively less acute than in most other sections of the United States. Apple maggot is serious in the eastern part of the section. The rosy apple aphid is also an important apple insect in the section and may cause serious losses in some seasons.

VARIETIES

Until recent years the Baldwin has been the principal variety throughout all the section except the most western portion. The McIntosh has been widely planted in recent years and is now the leading variety in the section as a whole. Rhode Island Greening, Northern Spy, Wealthy, Delicious, Ben Davis, and Oldenburg (*Duchess*) are the other most important varieties. In recent years Cortland has been planted extensively. Jonathan and Wagener are important varieties in Michigan but not in the other States. Rome Beauty and Stayman Winesap are produced in considerable quantities in the more southern parts.

CENTRAL ATLANTIC SECTION

LOCATION AND CLIMATE

The central Atlantic section is bounded on the north by the southern limit of the northeastern section, or the line extending westward from New York City. The western boundary follows the summit of the Appalachian Mountain system, which extends in a southwesterly direction roughly parallel to the coast line as far as northern Georgia. Northern Georgia represents the southern limit of commercial apple production in this part of the United States. This section includes southeastern Pennsylvania, central and southern New Jersey, all of Delaware and Maryland, the eastern part of West Virginia, all of Virginia, North Carolina, South Carolina, and northern Georgia. In recent years it has produced 20 to 25 percent of the apple crop of the United States.

Along the northern border of this section the interval between the time of apple bloom and the time when severe freezing weather may be expected in the fall will average from 165 to 170 days; in the southern part of the area the interval will usually be 200 days. Thus in the northern part varieties requiring 160 to 165 days for full development can be grown successfully, whereas in the southern sections those requiring even a longer period can be grown.

Throughout most of this section average summer temperatures range from 70° to 75° F., or approximately 5° higher than in the northeastern section. A few orchards located at elevations of about 2,000 feet have a temperature range of 65° to 70° during the summer. The territory from Chesapeake Bay southward through eastern Virginia and through much of North and South Carolina ranges above 75°. Relatively few apples are grown in this warmer area. The main centers of apple production in this section are located immediately east of the Appalachian Mountains at sufficiently high elevations that the mean growing-season temperature is below 75°. The Appalachian Mountains to the westward tend to give protection from extremely low winter-temperature conditions. Minimum winter tem-

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peratures are rarely lower than from −10° to −15°, and injury to apple trees from low temperature rarely occurs. Also, in part due to the influence of these mountains, destructive spring frosts or freezes are relatively rare in orchards well located with respect to air drainage.

Precipitation throughout most of this section is between 40 and 45 inches per year. The Potomac Valley, which represents the most intensively developed apple district, has a slightly lower rainfall, averaging from 35 to 40 inches. In most of the section, growing-season precipitation from April to September, inclusive, ranges from 21 to 24 inches per year. Summer rainfall fluctuates more than in the northeastern section, so that periods of long absence of rainfall are more likely to occur here than farther north. Orchards on shallow soils frequently suffer from insufficient moisture during dry seasons.

FIGURE 4.—Typical apple orchards on the rolling foothills in the Shenandoah-Potomac Valley section.

TOPOGRAPHIC FEATURES

The higher ranges of the Appalachian Mountains bounding the western side of this section generally are from 3,000 to 4,000 feet in elevation and afford considerable protection from temperature extremes, both during the winter and the spring. A number of lower ranges roughly paralleling the higher ones to the west cut the land east of the mountains into a series of valleys. Most of the orchards are located on the lower slopes of these ranges. The apple orchards of southern New Jersey, Delaware, and that part of Maryland lying east of the Chesapeake Bay are on Coastal Plain soils mostly sandy in nature. The principal orchards adjacent to the mountains in the Potomac basin and to the southward are planted on soils of limestone or sandstone formation. The limestone soils are generally deep, well-drained, and relatively high in fertility. The sandstone or shale soils

are generally more shallow, more subject to erosion, and lower in fertility, but they are satisfactory for apple production if sufficiently deep. Many orchards have been planted on sandstone soils not over 2 feet deep. However, such orchards suffer severely from drought during periods when rainfall distribution is poor and are usually short-lived and not highly productive. Shalestone soils 3 feet or more in depth are generally satisfactory for apple production in this section. There is a limited amount of chert soils, generally lying at elevations above 1,000 feet. These chert soils are stony, but they are deep and open, not subject to erosion, and excellent for apple production.

The most intensively developed apple district is in the upper Potomac drainage basin, and includes south-central Pennsylvania, western Maryland, eastern West Virginia, and northern Virginia (fig. 4). Southwestern Virginia, western North Carolina, and northern Georgia also have important apple plantings. In the Coastal Plain Belt of southern New Jersey, Delaware, and eastern Maryland, early varieties form a larger proportion of the planting than in other parts of the section.

DISEASE AND INSECT CONDITIONS

Although apple scab is the most serious fungus disease affecting apples throughout this section, a number of other diseases are important. Apple scab on the whole is easier to control here than in the more northerly districts. While conditions may be very favorable for the spread of the disease in the early spring, the higher temperatures prevailing from May until harvest are unfavorable for scab infection. Under the higher summer temperatures that prevail in parts of the section, such diseases as bitter rot and fruit spots are important. Because of the prevalence of these diseases and the higher temperatures during the growing season, copper fungicides are generally used for spraying throughout the territory from mid-June until the end of the season. Prebloom and early afterbloom sprays are generally of sulfur fungicides, as in the northeastern section.

Control of the codling moth in intensively developed areas is difficult, particularly where the temperatures in the growing season are high. In the more isolated and higher lying mountain orchards it can be controlled with as little spraying as in any part of the United States. In certain seasons the rosy apple aphid causes severe loss if control measures are not used. Curculio is a serious insect in unsprayed orchards, but is usually controlled where codling moth sprays are systematically applied.

VARIETIES

The two leading varieties, York Imperial and Stayman Winesap, are approximately equal in number of trees throughout the section. The third variety in number of trees is the Winesap, followed in order by Delicious, Rome Beauty, Ben Davis, Grimes Golden, Jonathan, and Yellow Transparent.

In the northern part of the section Stayman Winesap is the most important variety, leading all others in New Jersey, Pennsylvania, and Maryland. Through West Virginia and northern Virginia, the York Imperial is the leading variety, and in central and southern Virginia the Winesap is the most important. In recent years Delicious has been rather widely planted throughout the section.

THE OHIO BASIN SECTION

LOCATION AND CLIMATE

The Ohio Basin section includes substantially the drainage basin of the Ohio River and central and southern Illinois. It extends from the Allegheny Mountains on the east to the Mississippi River on the west. A few apples are grown in northern Mississippi and Alabama, marking the southern limit of apple production in this section. It includes Tennessee, Kentucky, the southern two-thirds of Illinois, Indiana, and Ohio, and that part of West Virginia lying west of the Allegheny Mountains. In recent years this section has produced 10 to 11 percent of the apple crop of the United States.

The length of the growing season in this section is substantially the same as in the central Atlantic section. Along the northern border the season from full bloom until severe freezing weather in the fall is 165 to 170 days. The average growing season temperature is slightly higher than in the central Atlantic section, the principal apple areas being in regions where the June to August temperatures average above 75° F. Annual precipitation will average between 35 and 40 inches in the northern part of the section and upward to 50 inches in the southern part. The most concentrated apple areas, located along the Ohio River, are in a region with a mean precipitation of about 40 inches per year. Approximately half of this precipitation comes during the growing season. Although droughts are not more frequent than in the Potomac basin they may be more injurious to trees in shallow soils because of the slightly higher prevailing temperatures. Serious damage to trees as a result of prolonged drought is not likely to occur in orchards located on soils of good water-holding capacity as much as 3 to 4 feet in depth.

TOPOGRAPHIC FEATURES

This area as a whole does not have the protection afforded by high mountain ranges or large bodies of water, such as characterized the northeastern and central Atlantic sections. With no mountain ranges to reduce the severity of cold waves moving out of the Northwest, the hazard of crop losses due to spring freezes is greater throughout this section than in those farther east. Much of the land, particularly in the orchard districts, is rolling, and many of the orchards are so located that some local protection is secured. For the territory as a whole, however, the hazard of spring freezes during or following bloom is relatively high. The elimination of most of the crop during certain seasons as a result of frost accentuates the tendency to biennial bearing. The total production during high crop years has been approximately three times the production during low crop ones.

Soils throughout the territory may be sandstone, shale, or limestone formation. Most of them are well drained and are satisfactory fruit soils if sufficiently deep and retentive of water. The shales particularly are susceptible to erosion and require careful handling to retain fertility.

The most intensively developed fruit belts are on the rolling lands adjacent to the Ohio River and some of its tributaries. Extensively developed areas occur in eastern and southern Ohio, and in northern Kentucky adjacent to the Ohio River; in Indiana adjacent to the Ohio

and Wabash Rivers; in southern Illinois adjacent to the Ohio River; and in western Illinois adjacent to the Mississippi River.

DISEASE AND INSECT CONDITIONS

Apple scab is frequently very difficult to control during the early growing period. From the time of the petal-fall spray onward, however, temperatures are usually sufficiently high, so that there is little further spread of the disease. If the early sprays are not applied at the proper time and in a thorough manner, the loss from the disease may be heavy. With the relatively high summer temperatures that prevail, bitter rot, blotch, and sooty blotch are important diseases. Control of the codling moth in the intensively developed fruit areas is difficult because of the relatively high growing-season temperatures. More isolated orchards may be kept clean with a moderate spray program, but in the older areas where there is extensive orchard planting and particularly where certain orchards are neglected, codling moth control is extremely difficult.

VARIETIES

Several varieties are grown extensively throughout the territory, including Rome Beauty, Grimes Golden, Jonathan, Stayman Winesap, Delicious, Winesap, Ben Davis, and Yellow Transparent. In Tennessee the apple industry is based mainly on early varieties, with Yellow Transparent and Early Harvest being most widely planted in commercial orchards. In Illinois the Yellow Transparent is second only to Jonathan in number of trees. Delicious and Golden Delicious have been rather widely planted in recent years. Willowtwig is an important variety in the western Illinois section.

SOUTHWESTERN SECTION

LOCATION AND CLIMATE

The southwestern section extends westward to the Rocky Mountains from the Mississippi River. Its northern limit may be considered the northern boundary of Missouri and a continuation of that line westward. It includes all of Missouri, Arkansas, Oklahoma, and Kansas, and southern Nebraska. A few scattered orchards are found in Texas, although there is little production in that State or in western Oklahoma, western Kansas, or western Nebraska that can be considered commercial. The principal apple regions lie along the Missouri River in Missouri, northeastern Kansas, and southeastern Nebraska, and in the Ozark region of northwestern Arkansas, southwestern Missouri, and eastern Oklahoma. This section now produces from 3 to 4 percent of the apple crop of the United States. Production since 1930 has averaged only slightly more than half that of the 5-year period 1920–24.

Throughout most of the section the mean summer June to August temperatures average from 75° to 80° F. Even in the northern part of this section the growing season is sufficient for such long-season varieties as Winesap to mature. Precipitation averages from 45 to 50 inches per year in most of Arkansas, 40 to 45 inches in the southern half of Missouri, 35 to 40 inches through northern Missouri and east-

ern Kansas, and below 35 inches in Nebraska, western Kansas, and western Oklahoma. Relatively few apples have been planted where the precipitation is under 30 inches per year.

TOPOGRAPHIC FEATURES

There are no important mountain ranges or large bodies of water which have the effect of greatly modifying the climatic conditions in this section. The Ozark Plateau in southern Missouri and northwestern Arkansas affords local slopes valuable for air drainage, but the mountain ranges are not sufficiently abrupt or high to afford much protection against general freezing conditions. Spring growth and flower development may be followed by freezing weather that destroys a great deal of the crop. The proportion of years during which the crop is seriously reduced by spring freezes is greater in this section than in most others where commercial orchards are planted. These periods of spring cold are likely to be accompanied by winds that reduce the protection afforded by air drainage.

The orchards adjacent to the Missouri River are largely located on rolling loess soils that are very deep and allow for deep root penetration. On these rolling lands heavy summer rains frequently result in much run-off rather than water penetration. Special treatments such as terracing, contour planting, or mulching to prevent run-off and to insure greater penetration of water are valuable and desirable in many of these orchards, because the total rainfall is not in excess of the needs of the trees in mature orchards.

In the Ozark section soils are stony and relatively shallow in many cases. Periods of prolonged summer drought are of relatively frequent occurrence. During these periods trees on shallow soils suffer severely for lack of water. Summer temperatures are high, and the demands of the trees for water are greater than in the more humid sections of the country.

Although winter conditions are usually not extremely severe, very sharp drops in temperature frequently occur, causing considerable winter injury, particularly in orchards weakened by drought or other unfavorable conditions during the preceding summers. As a result of injury by drought and low winter temperatures, orchards are usually relatively short-lived through much of the section.

DISEASE AND INSECT CONDITIONS

In common with the other apple sections having relatively high summer temperatures, most of the scab infection in this section occurs early in the growing season. If satisfactorily controlled at that time, loss from scab is not severe; however, if orchards are not thoroughly sprayed at the beginning of the growing season, loss of young fruit and leaves as a result of this disease may be severe.

During humid seasons bitter rot may cause severe loss in apples, particularly in the southern part of the section. In the past this disease has been extremely destructive, but in recent years, owing to a succession of relatively dry summers and better control measures, prevalence of the disease has decreased. Should a succession of humid summers occur, however, it would probably again be a serious factor. Blotch has also been a serious disease through most of this section.

Codling moth control is difficult in the more intensively developed areas. The hot and usually moderately dry summers are favorable for the development of the insect, and many orchards not thoroughly sprayed add to the difficulties of the commercial grower.

The hazard resulting from the probability of spring freezes, summer drought, and disease and insect conditions, together with winter injury in certain sections, account for the decline of apple growing in the section as a whole. Generally the orchards on the stronger soils adjacent to the Missouri River are in better shape than those farther south that are located on soils having less water-holding capacity.

VARIETIES

Ben Davis was formerly the leading variety through much of this section, but the number of trees of this variety has declined greatly in recent years. It suffered more severely than other varieties as a result of a succession of dry summers (1930–36). Blister canker also killed many Ben Davis trees. At the present time Jonathan is the leading variety throughout most of the section. Other important varieties include Delicious, Winesap, Grimes Golden, and Stayman Winesap.

NORTH-CENTRAL SECTION

LOCATION AND CLIMATE

The north-central section is bounded on the south by the southern boundary of Iowa and a continuation of that line across Illinois and Nebraska, extending north to the Canadian line. Thus it includes all of Iowa, Wisconsin, Minnesota, North Dakota, South Dakota, northern Illinois, and northern Nebraska. This section as a whole is not important apple-raising territory, as it produces only about 2 percent of the total crop of the United States. Orchards are scattered along the Missouri River in Nebraska and Iowa, more or less through southern Iowa, and along the Mississippi River in eastern Iowa, southeastern Minnesota, and western Wisconsin. The more important areas in Wisconsin are in the territory adjacent to Lake Michigan. There is also an area in northern Wisconsin protected by Lake Superior that has some commercial production.

Along the southern border of this section mean temperatures for the 3 summer months, June through August, range from 70° to 75° F. Throughout much of the section summer temperatures range from 65° to 70° and in northern Wisconsin are under 65°. In the southern part varieties adapted to the sections of the United States having a moderately long growing season are largely grown. In the northern sections only varieties that are outstandingly resistant to low temperatures can be grown successfully.

Throughout most of this section where apples are grown rainfall ranges from 25 to 35 inches per year. Westward in North Dakota, South Dakota, and western Nebraska rainfall is less, and apples are rarely grown except in occasional home plantings. Throughout the section as a whole low winter temperatures cause injury to trees and constitute a major hazard; therefore, trees of all but the more hardy varieties are usually relatively short-lived. Extensive fruit-breeding work is being conducted to obtain hardier varieties well adapted to this section.

TOPOGRAPHIC FEATURES

This section is directly exposed to cold waves that sweep down from the Canadian prairies. As a result extremely low winter temperatures and abrupt drops in temperature frequently occur. Spring frosts also constitute a hazard, although a loss of crop from this cause is less likely to occur in this section than farther south.

DISEASE AND INSECT CONDITIONS

Apple scab is the only fungus disease likely to cause serious loss in the section, and this loss may be considerable in seasons having relatively frequent spring rains. With a relatively short and cool growing season, the codling moth is much easier to control than under the warm conditions in more southerly sections.

VARIETIES

In southern Iowa and in the sections of Wisconsin bordering on Lake Michigan, Jonathan, Grimes Golden, Delicious, and to some extent Winesap and Stayman Winesap varieties are grown. In the more northerly regions Wealthy, McIntosh, Oldenburg, and Yellow Transparent are mainly grown, because these hardy varieties withstand the rigors of winter temperatures better than most other kinds. Haralson, a new variety from Minnesota, is considered promising. Such new varieties as Joan and Secor from the Iowa Agricultural Experiment Station are also being planted. The variety Anoka from the South Dakota Agricultural Experiment Station appears to be extremely hardy.

THE WESTERN SECTION

LOCATION AND CLIMATE

The western section includes all the territory from the Rocky Mountains on the east to the Pacific coast. With the exception of parts of California, almost all the commercial production in this section is under irrigation. Apple production is located in numerous valleys that are in most instances more or less surrounded by mountains. Commercial apple growing in this section has assumed large proportions mainly in the last 35 years. In recent years production in these western districts has averaged about 34 percent of the apple crop of the United States.

Most of the western districts are characterized by heavy production per tree and per acre. Summer weather normally consists of clear, nearly cloudless days, with high light intensity. This favorable light condition, together with ample water for irrigation and relative freedom from spring frosts and freezes, has resulted in extremely heavy and uniform production. Thus from 1931 to 1938 the total annual production for the Western States as a whole was within 10 percent above or 10 percent below 50,000,000 bushels, a uniformity record not approached by any other apple section in the country.

Production per bearing tree averages more than 4 bushels for the section as a whole, and in Washington State it averages about 7 bushels. This is in contrast with average yields of only about 1.2 bushels per bearing tree in the Mississippi drainage basin and 1.7 bushels in the northeastern and central Atlantic sections.

The cost of production per packed bushel under western conditions apparently averages somewhat more than in most of the Eastern States. In the western districts costs per acre are much higher than in eastern orchards because of the necessity for irrigating, more intensive production practices including pruning, fruit thinning, and spraying, more expensive packaging, generally higher wages for labor, and higher tax rates. With higher per-acre production, however, the costs per packed bushel are not as much higher in the Western States as might be expected from the per-acre costs.

Because of the greater amount of sunshine during the growing season, the absence of summer rain, and ample moisture from irrigation, fruit from western orchards is of larger average size and of better color than the same varieties from eastern orchards.

The Pacific Coast and Mountain States, which usually produce a little more than one-third of the apple crop, had in 1935 only 9.7 percent of the population of the United States. Thus at least two-thirds of the apple crop produced in that section must find markets outside the section. As the important consuming centers are 2,000 to 3,000 miles from these producing centers, most of the crop must be transported long distances, which adds to production and marketing costs. Although the western fruit usually sells at higher prices in consuming markets than most of the eastern fruit, returns to growers in the West have generally been less per bushel than those to growers in the East, particularly during years of low apple prices. When these prices are relatively high, the greater productiveness of western orchards generally results in greater total returns per acre than are obtained from eastern orchards.

Because of the extent and commercial importance of apple growing in this section, the major districts will be dealt with in some detail.

WENATCHEE, WASH., DISTRICT

The Wenatchee, Wash., district lies just east of the Cascade Mountains in north-central Washington in the valley of the Columbia River and its tributaries the Wenatchee, the Okanogan, and several smaller rivers. The orchards are mainly at an elevation of from 700 to 2,500 feet above sea level. Most of the orchards are located on bench lands along the rivers at sufficient elevations above the rivers to provide excellent air drainage (fig. 5); consequently spring frosts are rarely a factor in crop reduction except for small local areas. Summer temperatures, June to August, inclusive, are relatively cool, ranging from 65° to 70° F. in most of the orchard areas. Day temperatures are relatively high, but the nights are cool, so that the mean temperature is moderate for the summer season. Because of the high mountain range to the westward, precipitation in the section is very low, generally ranging from 7 to 10 inches per year, practically all of which comes during the winter months. Soil is mostly of granitic origin, medium to light in texture, but deep and well drained. Some of the soil is so light as to make irrigation difficult. Normally 30 to 35 inches of irrigation water in addition to the precipitation is used in a season. Ample water for irrigation is available through most of the district.

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FIGURE 5.—Typical apple orchards along the Columbia River, Wenatchee, Wash. (Courtesy Acme Co., Wenatchee, Wash.)

THE YAKIMA VALLEY DISTRICT

The Yakima Valley, second only to the Wenatchee district in total apple production in the western section, is located 100 miles south of the Wenatchee district and directly east of the Cascade Range of mountains in the valley of the Yakima River. Orchards are located along the Yakima Valley for a distance of 75 miles or more. The lower valley area has higher summer temperatures, ranging above 70° F. for the 3 months, than those of the upper part of the valley where most of the apple plantings are now located, which range from 65° to 70°.

The Yakima Valley is broad, and in some of the orchards air drainage is not perfect; thus the frost hazard is somewhat higher on the whole than in the Wenatchee area. However, many of the fruit locations of the Yakima Valley have excellent air drainage and are as free from frost as any fruit-growing section of the country.

Soils are somewhat more variable than in the Wenatchee district, and some orchards have been located on relatively shallow soils where unusual care must be taken in irrigation to provide ample moisture for the trees.

DISEASE AND INSECT CONDITIONS IN THE WENATCHEE AND YAKIMA DISTRICTS

In the Yakima and Wenatchee districts problems of insect and disease control do not differ greatly. Fungus diseases in both sections are relatively unimportant. Apple mildew occasionally causes some loss. Fungicide spraying is not generally practiced in commercial orchards.

With dry summer seasons and a large concentration of apple acreage, problems of insect control are extremely serious. Codling moth control is most difficult in the warmer areas lying at the lower elevations, and from 6 to 10 sprays per season are normally required to protect the fruit at these lower elevations. In the higher lying orchards protection is afforded by three to six codling moth sprays.

The various species of red spider prevalent in the districts are second only to the codling moth in the amount of injury that they cause and in difficulty of control. In many orchards special sprays for red spider control are necessary.

OTHER WASHINGTON DISTRICTS

Apples have been extensively planted in the valley of the Spokane River, eastward from the city of Spokane. This district is subject to low winter temperatures that have caused serious damage to trees. The soil is very open and consequently difficult to irrigate. Mainly because of winter injury, this section has never obtained production in proportion to the area of orchards originally planted.

In the Walla Walla district also a considerable apple acreage has been planted. As this district has relatively high summer temperatures and has a higher frost hazard than most other districts of the State, the apple industry there has tended to recede.

The White Salmon district lying just north of the Columbia River in Washington and opposite the Hood River Valley in Oregon is a relatively small section but is rather intensively planted to apples.

Varieties and conditions are essentially the same as those in the Hood River Valley.

VARIETIES GROWN IN WASHINGTON DISTRICTS

For Washington State as a whole, the Delicious variety, including the color sports, led in number of trees in 1936, with 35 percent of the total. Winesap was second, with 33 percent, followed by Jonathan, 11 percent; Rome Beauty, 8 percent; and Yellow Newtown, 3 percent. Thus these five varieties comprised 90 percent of the planting.

OREGON DISTRICTS

The most important apple producing district in Oregon is in the valley of the Hood River, a tributary of the Columbia River, in the north-central part of the State. The orchards are planted from the Columbia River for a distance of about 15 miles up the valley, which is almost completely surrounded by relatively high mountains. Winter temperatures are normally mild, but occasional very low temperatures have caused serious damage to trees. Following tree injury from the low winter temperatures in 1919, the perennial canker disease became established on injured trees. Additional winter injury occurring in 1924–25 resulted in further spread and development of the disease. The combination of winter injury and disease has resulted in the removal of much of the older acreage in the valley. Younger orchards have been established on favorable sites, but the present apple production is less than that of 20 years ago. In the early part of the twentieth century the Hood River Valley was the most famous of the western apple districts. It is still an important producing center, but the tonnage produced is far less than that in the major Washington districts. Summer temperatures range around 65° F. The codling moth presents some difficulty in the lower valley, but at the higher elevations it can be readily controlled. Yellow Newtown is by far the leading variety, with Delicious, Esopus Spitzenburg, Rome Beauty, and Ortley also important.

Rather extensive plantings were formerly made in the Rogue River Valley in southern Oregon, but this district has steadily receded in apple production and is now primarily known as a pear-producing district. Because climatic conditions and soil are less favorable for apple production than for pears, the apple production in recent years has been relatively small.

Extensive farm orchards and some commercial orchards of apples are scattered throughout the nonirrigated Willamette Valley, in western Oregon. Large plantings were made in this district from 1905 to 1910, but, because most of these proved less satisfactory for apple production than plantings in the irrigated sections, orchards have largely passed out of production.

IDAHO DISTRICTS

The principal apple-producing districts in Idaho are in the valleys of the Boise and Payette Rivers and other tributaries of the Snake River in southwest Idaho near the Oregon line, although there is some production at various points along the Snake River from Lewiston in northern Idaho to Twin Falls in the south-central part of the State.

In the main territory of southwestern Idaho the orchards are at elevations of from 2,000 to 3,000 feet. The summer temperatures are 70° F. or above, ranging slightly higher than in the main apple districts of Oregon and Washington. In the relatively broad valleys where local air drainage is poor there is appreciable frost hazard. The soil tends to be somewhat heavy in some parts of the district. High water table in some of the irrigated orchards has caused loss of or damage to trees. The insect problems do not greatly differ from those in the other western sections, codling moth being relatively difficult to control except at the higher elevations. The leading varieties grown include Rome Beauty, Jonathan, Delicious, and Winesap.

UTAH DISTRICT

Most of the apple orchards in Utah are located adjacent to Great Salt Lake and mainly to the southeast and south of the lake. Apple production in this district has never assumed large proportions. The district lies at an elevation of about 4,000 feet and has average summer temperatures of about 70° F. Winter temperatures may be sufficiently low to cause injury to trees. Problems of production, including insect control, are not greatly different from those of other western districts. Jonathan is the leading variety, followed by Rome Beauty and Delicious.

WESTERN COLORADO DISTRICTS

The main center of apple production in Colorado is in the valley of the Grand River and its tributaries in the west-central part of the State. In the vicinity of Grand Junction much of the land was formerly in apples, but most of these orchards have disappeared as a result of extremely difficult insect-control problems, high-water table, relatively poorly drained soil, and related difficulties. At present most of the apple production lies at higher elevations where insect control is less difficult.

The lower parts of this district have summer temperatures ranging from 70° to 75° F. Conditions are very favorable for codling moth development. In Colorado, as in most of the dry western section where temperatures from June to August, inclusive, range above 70°, codling moth control has in recent years become so difficult as to make apple growing of doubtful expediency.

CALIFORNIA DISTRICTS

The principal apple production in California is in coastal counties in the central part of the State lying both to the north and south of San Francisco. North of San Francisco, mainly in Sonoma County, an extensive area is devoted primarily to the growing of the Gravenstein variety. In that district this variety is harvested in July and is shipped throughout the United States as an early summer apple. A number of others, including Rome Beauty, Jonathan, and Yellow Newtown, are also grown.

South of San Francisco in the vicinity of Watsonville, another extensive apple district occurs. This also is a coastal area with Yellow Newtown and Yellow Bellflower the two leading varieties. In both of these coastal districts average summer temperatures range from 60° to 65° F. Orchards are grown mainly without irrigation. The annual

rainfall is about 40 inches in the district north of San Francisco, and from 25 to 30 inches in the Watsonville district. Some supplemental irrigation is practiced in the latter district. With very cool growing-season conditions and with considerable high fog, transpiration is lowered so that the orchards thrive on less water than would be possible in other parts of the country. Because red varieties do not color well owing to lack of bright sunlight in these districts, green or yellow varieties predominate. As a result of the very cool growing seasons, problems of codling moth control are not difficult, although spraying is necessary. Fungus diseases do not present a serious problem, although apple mildew may cause some damage.

The third most important apple district in California lies at an elevation of 2,500 to 3,500 feet in San Bernardino County about 100 miles east of Los Angeles. At the lower elevations trees may not have a sufficiently long dormant period during the winter to grow well in the spring. This lack of winter cold limits the commercial production of apples at the lower elevations in this district, as it limits the southward development of apple growing in other localities. Precipitation is about 20 inches, supplemented by irrigation from wells. Rome Beauty, Winesap, and Delicious are the principal varieties grown.

OTHER WESTERN DISTRICTS

Other western producing districts are located in the valley of the San Juan River in northwestern New Mexico, and in the valley of the Bitter Root River in western Montana. In the San Juan Valley, leading varieties include Delicious, Rome Beauty, Jonathan, and Winesap. In the Bitter Root Valley, winter injury has been severe on the more tender varieties. Production is largely of McIntosh.

CHARACTERISTICS OF LEADING AMERICAN APPLE VARIETIES

CHANGES IN RELATIVE IMPORTANCE OF VARIETIES

Marked changes in the relative importance of leading apple varieties in the United States have occurred during the past 25 years. The estimated numbers of trees of leading varieties for the United States as a whole, made as a result of a survey in 1928, are listed in table 1. No accurate surveys are available for most of the States since that time. Also included in the table is the writer's estimate as to whether the trees of the different varieties have increased in number, remained steady, or decreased since 1928.

By 1928 Delicious had become the most widely planted tree in American apple orchards, and plantings of this variety and its color strains have undoubtedly increased since that time. Winesap was a close second in that year, and the number of trees of this variety has probably remained about constant. Jonathan, in third place, has not increased since 1928, and figures for the country as a whole would probably show a decrease, due to a reduction in the number of Jonathan trees in some of the Pacific coast districts and a decrease in orchard population as a whole throughout the southwestern sections where Jonathan is heavily planted.

TABLE 1.— *Apple trees of leading varieties in commercial orchards in the United States in 1928, with notes as to trends since that time* [1]

Variety	Apple trees in 1928		Trend since 1928
	Estimated number	Percent of total	
Delicious	6,826,000	8.4	Moderate increase.
Winesap	6,617,000	8.2	Steady.
Jonathan	6,334,000	7.8	Slight decrease.
Baldwin	5,519,000	6.8	Marked decrease.
Stayman Winesap	5,076,000	6.3	Steady.
Ben Davis	4,529,000	5.6	Marked decrease.
Rome Beauty	4,180,000	5.2	Steady to slight increase.
York Imperial	3,604,000	4.5	Steady to slight decrease.
McIntosh	3,340,000	4.1	Marked increase.
Grimes Golden	2,465,000	3.0	Moderate decrease.
Yellow Newtown	2,326,000	2.9	Do.
Wealthy	2,073,000	2.6	Do.
Yellow Transparent	1,863,000	2.3	Do.
Gano and Black Ben	1,769,000	2.2	Do.
Rhode Island Greening	1,451,000	1.8	Do.
Northern Spy	1,395,000	1.7	Do.
Gravenstein	1,285,000	1.6	Steady to slight decrease.
Oldenburg (*Duchess*)	1,197,000	1.5	Marked decrease.
Arkansas (*Black Twig*)	970,000	1.2	Do.
Golden Delicious	941,000	1.2	Marked increase.
Esopus Spitzenburg	592,000	.7	Marked decrease.
Wagener	583,000	.7	Moderate decrease.
Stark	524,000	.6	Do.
Winter Banana	439,000	.5	Marked decrease.
King David	416,000	.5	Do.
Limbertwig	338,000	.4	Moderate decrease.
Tompkins King	324,000	.4	Marked decrease.
Cortland	303,000	.4	Marked increase.
Yellow Bellflower	296,000	.4	Moderate decrease.
Miscellaneous	13,288,000	16.5	

[1] Data on tree numbers from the mimeographed report, ESTIMATED NUMBERS OF APPLE TREES BY IMPORTANT VARIETIES AND AGES IN COMMERCIAL ORCHARDS IN 41 STATES. U. S. Dept. Agr., Bur. Agr. Econ., in cooperation with State colleges and State departments of agriculture.

Baldwin was in fourth place and Ben Davis in sixth place in 1928. There has been a very sharp reduction in numbers of trees of both of these varieties since that time. Nearly 2,000,000 Baldwin trees in New York and New England are estimated to have been killed or so seriously injured by the severe freezes of the winter of 1933 34 that their commercial value was destroyed. The Ben Davis variety suffered probably more than any other as a result of the prolonged drought periods that have occurred in the middle western districts intermittently since 1930. An accurate census at the present time would undoubtedly show both Baldwin and Ben Davis below Stayman Winesap, Rome Beauty, McIntosh, and probably York Imperial. It is believed that Stayman Winesap and Rome Beauty plantings have been about equal to tree removal since 1928. The McIntosh variety would show a marked increase since 1928, as it has been the most popular variety for planting throughout the large northeastern apple belt. The remaining varieties listed in table 1 all would show moderate to marked decreases in tree population with the exception of Golden Delicious and Cortland. Golden Delicious has been rather widely planted, particularly through the Middle West during recent years; Cortland has been popular for planting in the northeastern section.

The total number of trees of bearing age in all orchards decreased at a rate of over 1 percent a year during the period 1930 35. Data are not yet available for 1940, but it is believed this downward trend has continued, though probably at a somewhat slower rate. Of the

24 leading varieties, only Delicious, McIntosh, Golden Delicious, and Cortland are believed to have increased in numbers during that time. Winesap, Stayman Winesap, and Rome Beauty held about constant, and all other varieties tended to decrease as tree removals exceeded plantings.

During the period 1909–13, the 10 leading varieties in the United States in order of their importance were Baldwin, Ben Davis, Northern Spy, Winesap, Rhode Island Greening, Jonathan, Rome Beauty, Early Harvest, Wealthy, and Grimes Golden. During the 25-year period between 1915 40, Baldwin, Ben Davis, Northern Spy, Rhode Island Greening, Early Harvest, and Wealthy dropped out of positions of leadership and were replaced with such high-dessert-quality varieties as Delicious, Stayman Winesap, and McIntosh. Thus a much larger proportion of the total apple production now than during the 1909–13 period consists of apples high in dessert quality.

TREE CHARACTERISTICS

Apple trees vary in shape from widespreading, with branches tending to come off at rather wide angles from the trunk, to nearly upright. In general, the more spreading type of tree is preferable for commercial production because spraying, pruning, fruit thinning, and fruit harvesting are facilitated. The tree shape for leading varieties is given in table 2.

Under vigor and ultimate size of tree (table 2) a rough evaluation has been made of each of these characteristics. Very vigorous growing varieties that tend to attain large size are not necessarily advantageous from the standpoint of commercial production. Varieties that attain only medium size can be planted somewhat more closely than trees that will become very large. Thus an orchard consisting of Winesap, Jonathan, Rome Beauty, and Golden Delicious could be planted somewhat more closely than could one of Baldwin, McIntosh, Delicious, and Stayman Winesap.

The age to first bearing, listed in table 2, is an extremely important consideration in establishing orchards. Although the age that trees may be expected to bear varies under different climatic and soil conditions, the relative order of bearing of the different varieties is substantially as listed. The years indicated represent the time to first appreciable production. Several additional years are required before the trees reach a capacity to produce full crops.

The tendency of the varieties to become biennial or to be annual producers is also indicated in the table. It is interesting to note that with the exception of some of the summer varieties there is a general correlation between the age at which the trees of a variety come into bearing and their tendency to bear regularly. Thus varieties that are slow to come into bearing have a stronger tendency to be biennial than those that bear at an early age. This probably is associated with the inherently greater tendency of these early bearing varieties to form flower buds.

It should be emphasized, however, that all varieties of apples will tend to become biennial if planted under conditions where the crop is likely to be a complete failure during certain years. Thus the almost complete loss of crop from spring frost is likely to throw an orchard into a strongly biennial condition regardless of the varieties grown.

TABLE 2.—*Tree characteristics of leading apple varieties*

Variety	Shape of tree	Vigor of tree	Ultimate size of tree	Age to first bearing	Tendency to annual or biennial production
Delicious	Upright spreading	Vigorous	Large	Medium (5 to 8 years)	Intermediate.
Winesap	Spreading	Medium	Medium	Medium (6 to 8 years)	Do.
Jonathan	do	do	do	Early (4 to 6 years)	Annual.
Baldwin	Upright spreading	Very vigorous	Large	Medium to rather late (8 to 10 years)	Biennial.
Stayman Winesap	Spreading	Vigorous	do	Early (4 to 6 years)	Annual.
Ben Davis	Upright spreading	Medium	Medium	do	Do.
Rome Beauty	Spreading	do	Medium to small	do	Do.
York Imperial	Upright spreading	Vigorous	Large	Medium (6 to 8 years)	Biennial.
McIntosh	Spreading	do	do	Early (4 to 6 years)	Annual.
Grimes Golden	do	Medium	Medium to large	Medium (6 to 8 years)	Intermediate.
Yellow Newtown	Upright spreading	do	Medium	Medium to late (8 to 10 years)	Biennial.
Wealthy	do	do	Medium to small	Early (4 to 6 years)	Do.
Yellow Transparent	Upright	do	do	do	Do.
Rhode Island Greening	Spreading	Vigorous	Medium to large	Medium (6 to 8 years)	Intermediate.
Northern Spy	Upright	Medium	do	Very late (10 to 14 years)	Do.
Gravenstein	Upright spreading	Vigorous	do	Medium (6 to 8 years)	Annual.
Oldenburg (*Duchess*)	Spreading	Medium	Medium	Early (4 to 6 years)	Intermediate.
Arkansas	Upright spreading	Vigorous	Large	Medium to late (8 to 10 years)	Biennial.
Golden Delicious	Spreading	Medium	Medium	Early (4 to 6 years)	Intermediate.
Esopus Spitzenburg	Upright	Vigorous	Large	Medium (6 to 8 years)	Do.
Wagener	Very upright	Medium	Medium	Early (4 to 6 years)	Do.
Stark	Upright spreading	Vigorous	Large	Medium (6 to 8 years)	Do.
Winter Banana	Spreading	Medium	Medium	Early (4 to 6 years)	Do.
Cortland	do	do	do	do	Annual.

Relative Disease Susceptibility

The relative susceptibility of the more important apple varieties to principal diseases is listed in table 3; also the susceptibility of the trees and fruit to spray injury is indicated.

Data in table 3 are of great importance from the standpoint of the spray program. Apple scab is by far the most serious fungus disease affecting apples. Control of the disease on very susceptible varieties in humid sections requires repeated applications of sulfur fungicides during the early growing season. If the leaves are also very susceptible to spray injury, such a program would reduce the productiveness of the tree through injury to the foliage system. It is interesting to note that Delicious, Stayman Winesap, Rome Beauty, and McIntosh are all very susceptible to scab but are all quite resistant to spray injury. On the other hand, York Imperial, and Jonathan are resistant to scab but susceptible to spray injury. Thus, where it is possible to do so, the choice of materials for spraying and the frequency of application might well be modified in these two groups of varieties.

Bitter rot is primarily important in the sections where summer temperatures and humidities are high. Varieties very susceptible to this disease, such as Ben Davis and Golden Delicious, are doubtful for planting in the more humid southern apple sections.

Cedar rust is an important disease in certain years throughout most of the apple-growing territory of the eastern United States. The value of varieties susceptible to this disease, such as Jonathan, Rome Beauty, York Imperial, and Golden Delicious, is reduced for orchards in areas where the red cedar is abundant.

TABLE 3. *Relative susceptibility of important apple varieties to principal diseases and to spray injury* [1]

Variety	Scab	Bitter rot	Fire blight	Cedar rust	Spray injury
Delicious	Very susceptible	Resistant	Very resistant	Very resistant	Resistant.
Winesap	do	Very resistant	do	do	Susceptible.
Jonathan	Resistant	Susceptible	Very susceptible	Very susceptible	Do.
Baldwin	Susceptible	Resistant	do	Very resistant	Do.
Stayman Winesap	Very susceptible	do	Resistant	do	Resistant.
Ben Davis	do	Very susceptible	do	Resistant	Very susceptible.
Rome Beauty	do	Resistant	Susceptible	Very susceptible	Resistant.
York Imperial	Resistant	do	do	Susceptible	Susceptible.
McIntosh	Very susceptible	do	do	Very resistant	Resistant.
Grimes Golden	Very resistant	Very susceptible	do	Resistant	Susceptible.
Yellow Newtown	Susceptible	do	do	Very resistant	Do.
Wealthy	do	Susceptible	Very susceptible	Very susceptible	Resistant.
Yellow Transparent	Resistant	do	do	Resistant	Do.
Rhode Island Greening	Susceptible	do	Susceptible	do	Do.
Northern Spy	do	do	do	do	Susceptible.
Gravenstein	do	do	do	Very resistant	Resistant.
Oldenburg (*Duchess*)	Resistant	do	Very susceptible	do	Do.
Golden Delicious	Susceptible	Very susceptible	do	Susceptible	Very susceptible.
Esopus Spitzenburg	do	do	Very susceptible	do	Susceptible.
Wagener	Resistant	do	do	Very resistant	Resistant.
Stark	Susceptible	Susceptible	Susceptible	Susceptible	Do.
Winter Banana	Resistant	Resistant	Resistant	Very susceptible	Do.
Cortland				Very resistant	

[1] Prepared by John W. Roberts, principal pathologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry.

Pollination Value and Requirements

In table 4 varieties are listed as to whether they are diploid or triploid in chromosome number, as to whether they are generally good or poor pollinizers, as to the degree to which they will set fruit with their own pollen, and as to the season of bloom.

In recent years it has been found that apple varieties may be diploids containing 34 chromosomes in the cells of vegetative tissues or triploids which have 51 chromosomes. In general, the triploid varieties produce little viable pollen and consequently are of little value as pollinizers for other varieties, whereas the diploid varieties are good pollen producers. The Winesap is an exception to this general grouping, as it is a diploid variety, but normally does not produce viable pollen.

Although some of the important apple varieties will set a partial crop of fruit with their own pollen, none of them are sufficiently self-fruitful to be depended upon to set full commercial crops without the necessity for cross-pollination. Thus, in establishing an orchard, varieties should be so arranged that all trees are within about three tree rows of another variety that is a good pollinizer and the blossoming period of which overlaps somewhat. Apple varieties normally bloom sufficiently close together so that early-blooming varieties are satisfactory for pollinating those that are midseason in blooming, and vice versa. Similarly, late-blooming varieties are usually satisfactory for pollinating midseason bloomers. It would be unsafe, however, to depend upon late-blooming varieties for the pollination of the early bloomers or vice versa.

TABLE 4.—*The pollination value and requirements of important apple varieties*

Variety	Diploid or triploid	Value as pollinizer	Degree of self-fruitfulness	Season of bloom
Delicious	D	Good	Self-unfruitful	Midseason.
Winesap	D	Worthless	do	Do.
Jonathan	D	Good	Slightly self-fruitful	Do.
Baldwin	T	Poor	Partially self-fruitful	Do.
Stayman Winesap	T	do	Slightly self-fruitful	Do.
Ben Davis	D	Good	do	Do.
Rome Beauty	D	do	do	Late.
York Imperial	[1] D ?	do	Partialy self-fruitful	Midseason to late.
McIntosh	D	do	Slightly self-fruitful	Midseason.
Grimes Golden	[1] D ?	do	Partially self-fruitful	Do.
Yellow Newtown	D	do	do	Do.
Wealthy	D	do	do	Do.
Yellow Transparent	D	do	do	Early.
Rhode Island Greening	T	Poor	Self-unfruitful	Midseason.
Northern Spy	D	Good	do	Late.
Gravenstein	T	Poor	do	Early.
Oldenburg (*Duchess*)	D	Good	Partially self-fruitful	Do.
Arkansas	T	Poor	Self-unfruitful	Midseason.
Golden Delicious	[1] D ?	Good	do	Do.
Esopus Spitzenburg	[1] D ?	do	Partially self-fruitful	Do.
Wagener	[1] D ?	do	Self-unfruitful	Early.
Stark	T	Poor	do	Midseason.
Winter Banana	[1] D ?	Good	do	Do.
Cortland	D	do	Slightly self-fruitful	Do.

[1] Chromosome number of varieties marked "D ?" have not been counted and reported, but all characteristics indicate that they are diploids.

FRUIT CHARACTERISTICS

Characteristics of the fruit of leading apple varieties are summarized in table 5. In the second column of that table is listed the approxi-

mate number of days from the time the trees are in full bloom until the fruit is at picking maturity. Investigations indicate that there is less variation than might be expected in this interval from season to season or in different parts of the country. Thus this time interval approximately indicates the ripening sequence of these varieties. An early blossoming season usually means that the fruit will reach picking maturity at a similarly advanced date in the summer or fall, whereas a late bloom usually means a late harvest.

Varieties requiring a long growing season, such as Winesap, Stayman Winesap, Rome Beauty, York Imperial, and Arkansas, are adapted only to parts of the country having a relatively long growing season and are not satisfactory under conditions of shorter seasons, such as prevail in the northeastern section. Although the apple districts in Washington and Oregon are relatively far north, the blossoming season coincides with that in the Potomac Valley, and the same varieties are well adapted to both these areas.

Under the headings size, color, shape of fruit, and texture of flesh, descriptive notes are given that indicate the usual condition of the different varieties. Fruit of varieties normally medium to large may be small if excessive crops are borne or if moisture supply or other growing conditions are unfavorable. The color of the fruit varies greatly with the exposure of individual fruits to light, with the crop produced on the tree, with the vegetative condition of the tree, and related factors.

TABLE 5.—*Fruit characteristics*

Variety	Approximate days after full bloom to picking maturity	Size of fruit	Color of fruit	Shape of fruit
	Number			
Delicious	140 to 150	Medium to large	Medium red (blush to 100 percent).	Oblong conic
Winesap	160 to 170	Medium to below medium.	Dark uniform red	Conical
Jonathan	140 to 145	do	Uniform bright red	Round to round conic
Baldwin	140 to 150	Medium to large	Medium red (blush to 100 percent).	do
Stayman Winesap	160 to 165	do	do	Roundish conic
Ben Davis	150 to 155	do	Striped medium red	Round conic to oblong conic.
Rome Beauty	160 to 165	Large	Medium red (blush)	Round to oblate
York Imperial	155 to 165	Medium to large	Light red (blush to 100 percent).	Oblate, oblique
McIntosh	125 to 130	Medium	Medium red (blush to 100 percent).	Roundish oblate
Grimes Golden	140 to 145	Medium to below medium.	Yellow	Roundish oblong
Yellow Newtown	160 to 165	Medium	do	Roundish oblate, sometimes oblique.
Wealthy	120 to 125	do	Medium red (blush to 100 percent).	Roundish oblate
Yellow Transparent	70 to 75	Small to medium	Yellow	Conic
Rhode Island Greening.	135 to 145	Medium to large	Green yellow	Roundish oblate
Northern Spy	145 to 155	Large	Bright striped red	Roundish conical
Gravenstein	110 to 115	Medium	Striped bright red (blush to 100 percent).	Oblate, angular
Oldenburg (*Duchess*)	90 to 95	do	Striped medium red (blush to 100 percent).	Roundish oblate
Arkansas (*Black Twig*).	165 to 170	Medium to large	Medium dull red (blush to 75 percent).	do
Golden Delicious	140 to 145	do	Yellow	Conic
Esopus Spitzenburg	145 to 150	do	Uniform bright red	Oblong conic
Wagener	135 to 145	Medium	Bright red (blush)	Oblate, irregular
Stark	140 to 150	Medium to above medium.	Medium to dull striped red.	Roundish conic
Winter Banana	120 to 125	Medium to large	Yellow, red blush	do
Cortland	125 to 130	Medium to above medium.	Medium red	Oblate

[1] Represents the time that most of the fruit may be safely held.
[2] Represents the maximum period for safe holding of fruit picked, handled, and stored under the best conditions.
[3] Susceptible to soft scald.

of leading apple varieties

Texture of flesh	Degree of acidity	Dessert quality	Cooking quality	Cold-storage season: Normal days [1] (number)	Cold-storage season: Maximum days [2] (number)	Tendency to storage scald
Crisp, juicy, mealy when overripe.	Low	Very good	Poor	90 to 120	180	Slight.
Hard, crisp, juicy	Medium	Good	Good	150 to 210	240	Medium.
Tender, crisp, juicy.	Medium to high	Very good	do	60 to 90	120	Slight.[3]
Hard, crisp, juicy	Medium	Fair to good	do	120 to 150	180 to 200	Medium to severe.
Firm, crisp, juicy	do	Very good	Very good	120 to 150	150 to 180	Severe.
Hard, dry, tough	do	Poor	Fair	120 to 150	240	Medium
Firm, crisp to mealy when overripe.	Medium to below medium.	Fair	Good	120 to 150	180 to 210	Do.
Hard, crisp	Medium	do	do	120 to 150	150 to 180	Severe.
Tender, juicy	do	Very good	do	60 to 90	120 to 150	Slight.[3]
Medium tender, crisp, juicy.	do	Good to very good.	do	60 to 90	120	Severe.
Hard, crisp, juicy	Medium to above medium.	Very good	do	150 to 180	240	Slight.
Tender, crisp, juicy	Medium to high	Good	do	0 to 30	90	Do.
Medium tender, juicy.	Very high	Poor	do	0	90	None.
Firm, fine grained, juicy.	Medium to high	Good	Very good	90 to 120	180	Severe.
Firm, fine grained, tender, juicy.	Medium	Very good	do	120 to 150	180	Slight.
Firm, crisp, juicy	Medium to high	Good	do	0 to 30	90	Do.
Firm, juicy, rather coarse.	High	Poor	Good	0 to 30	90	Do.
Hard, crisp, coarse, juicy.	Medium	Fair to good	do	120 to 150	180	Severe.
Firm, crisp, tender	do	Very good	do	90 to 120	150	Slight.
do	Medium to high	do	Very good	90 to 120	180	Do.
Firm, crisp, juicy	Medium	Good	Good	90 to 120	120 to 150	Severe.
Firm, crisp, coarse	do	Fair to good	do	120 to 150	180	Slight.
Firm, tender, rather coarse.	Medium to low	do	Fair	90 to 120	150	Do.
Tender, moderately juicy.	Medium	Good to very good.	Good	90 to 120	150	Medium.

The amount of acid in apples determines largely the sweetness or tartness of the fruit to the taste. None of the leading varieties are sufficiently low in acidity to be classed as sweet. Of the leading varieties, Delicious is lowest in acidity.

The rating of the different varieties as to dessert quality, and to a lesser extent as to cooking quality, will vary with each person. In table 5 the dessert-quality rating is that which is most generally applied to the varieties. It is interesting to note that the varieties planted most extensively in recent years are those that rate as good or very good in dessert quality. This should have the effect of improving the general quality level of apples marketed in the future as compared with that in the past.

The final column lists the tendency to storage scald of the various varieties. Although losses due to this trouble have decreased tremendously as a result of the use of oil-paper wraps and shredded oil paper in the packages, varieties showing medium to severe storage scald are still subject to some loss. Consequently, the tendency to develop storage scald is still a factor for consideration in connection with the evaluation of varieties.

COLOR STRAINS OF CERTAIN APPLE VARIETIES

Although fruit trees and other plants propagated by budding or grafting normally come like the parent from which the propagating wood is taken, occasionally mutations occur in the vegetative parts of the plants that change their character to some degree. Occasional branches are found in orchard trees on which the fruit varies in some respects, such as more or less color, earlier or later ripening, larger or smaller size, and other factors. As a result of search in commercial orchards, a number of such sporting branches have been found in most of the leading apple varieties that represent some modification from the parent. A number of these have been selected on the basis of improved color and in recent years have been extensively propagated and sold by commercial nurserymen as improved color strains. A few of these that have been grown under commercial conditions extensively enough to be evaluated at the present time are described in the following paragraphs.

Delicious Strains

The two most widely propagated strains of Delicious are Starking and Richared. Starking, under favorable conditions, develops a red color as much as 2 weeks in advance of the time the standard variety colors. The date of maturity of the fruit does not vary measurably from that of the standard variety. Under conditions favorable for color development, fruit of this strain develops a dark maroon red by the time the fruit is fully mature.

The Richared strain does not color quite so early as the Starking. At picking time mature fruit of this strain is usually more nearly completely colored than the standard variety and is of approximately the same shade of red as well-colored fruits of the standard variety.

The Shotwell Delicious has been propagated more recently but has not been so widely tested as the other two strains. So far as observed, it appears to be a good bright color when mature.

A few other strains of Delicious have been commercially propagated but have not been grown sufficiently to evaluate their merits.

Rome Beauty Strains

Two strains of red Rome Beauty have been rather widely planted. One of these, Gallia Beauty, may be of seedling origin but is apparently indistinguishable from Rome Beauty in tree character. The Cox Red Rome is of bud-sport origin. Both of these strains have a bright attractive red color and are much more uniformly colored than the standard Rome Beauty. The fruit may be somewhat smaller, and both have been reported to be slightly earlier in maturing and possibly not quite so good in storage quality as the standard Rome Beauty. Data in regard to size and storage quality, however, are not entirely dependable, as strictly comparable fruit has not been available for comparison.

The Black Rome was originated and was propagated to some extent in the Pacific Northwest. Apparently it is considerably darker than the standard Rome Beauty. Numerous other color sports of Rome Beauty have been found in orchards and are being tested to a limited extent.

Stayman Winesap Strains

The most widely tested color strains of Stayman Winesap are known as Staymared and Blaxtayman. Neither of these is outstandingly superior to the Stayman Winesap in color, although both carry somewhat more color at maturity than the parent variety. The Staymared is apparently similar to Stayman Winesap in quality of color but averages somewhat more at maturity. Blaxtayman is a darker and sometimes a duller shade of red. Neither of these strains appears to differ from the standard Stayman Winesap in the tendency of fruit to crack, the greatest weakness of this variety. Recently other strains not yet widely tested have been listed in nursery catalogs.

Jonathan Strains

Two strains of Jonathan have been propagated and tested somewhat, Jonared and Blackjon. Jonared appears to have a somewhat brighter color, the Blackjon being darker. Jonared appears to carry considerably more color than the parent variety.

Other Varietal Strains

Color strains of most of the other leading red-apple varieties, including York Imperial, Baldwin, Northern Spy, McIntosh, Esopus Spitzenburg, Gravenstein, and Oldenburg, are also offered for sale. Sufficient information relative to these strains is not available to warrant detailed discussion. In most cases the strains appear to carry somewhat more color than the parent variety. The prospective grower of these strains if possible should see them under orchard conditions and form his own judgment as to their merits as compared with the parent variety.

The earliest trees of the McIntosh variety were apparently largely of a good solid red type of color. Mutations to a less desirable striped type of fruit apparently occurred and were propagated by chance. Many of the later propagated trees of the variety are of these poorer colored strains. It is possible that the propagated color strains are not outstandingly superior to the best trees of the standard McIntosh variety, but propagation of trees from these solid color types should

be superior to the striped type that has been rather widely disseminated.

A considerable degree of caution is warranted in the use of the color strains. In some cases they have been propagated with relatively little preliminary testing. Although the best color strains of the red apple varieties appear to have much merit, there is no assurance that these strains are identical in all respects except color to the parent variety; size, storage quality of fruit, and other factors may also be affected. In a number of cases the shade of color in the strain appears to be less bright and attractive than that of the parent varieties. Thus the prospective grower of these color strains should make every effort to see bearing progeny trees of the different strains and reach his own decision as to which, if any, will be most desirable to use. Many growers will do well to plant a tree or two of the strains of the varieties in order to have first-hand information relative to the adaptation and value of such strains for his particular conditions.

The choice of the right varieties and strains for planting involves one of the most important decisions that the orchardist has to make. Varieties considered valuable at one time may be largely discarded 20 or 30 years later. Many varieties, such as Oldenburg, Ben Davis, and Esopus Spitzenburg, very popular for planting in 1910, have almost disappeared from later planting lists. If a new variety proves outstanding the grower who planted it early will be rewarded; if it develops weaknesses he will be penalized. On the basis of the experience of the past two or three decades it would appear that to have an important place new varieties must be good to very good in dessert quality, they must be very attractive in appearance, and the tree must be vigorous, productive, and hardy. If the fruit is of good storage and handling quality the value of the variety is greatly increased.

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